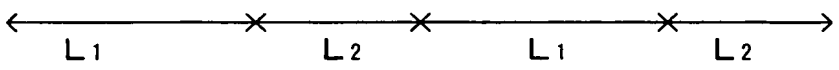
SIGNAL SEQUENCE FOR MULTIPATH ESTIMATION

$A_n = a_0\ a_1\ a_2\ \cdots\ a_{n-1}$ (ZCZ SEQUENCE)

$= + + + -\ \cdots\ 0\ 0\ 0\ 0\ +\ -\ +\ +\ \cdots\ 0\ 0\ 0\ 0\ \cdots$



TRANSMISSION DATA

$B_n = b_0\ b_1\ b_2\ \cdots\ b_{n-1}$

$C_n = c_0\ c_1\ c_2\ \cdots\ c_{n-1}$

$D_n = d_0\ d_1\ d_2\ \cdots\ d_{n-1}$

$E_n = e_0\ e_1\ e_2\ \cdots\ e_{n-1}$

: : : :

FIG. 1

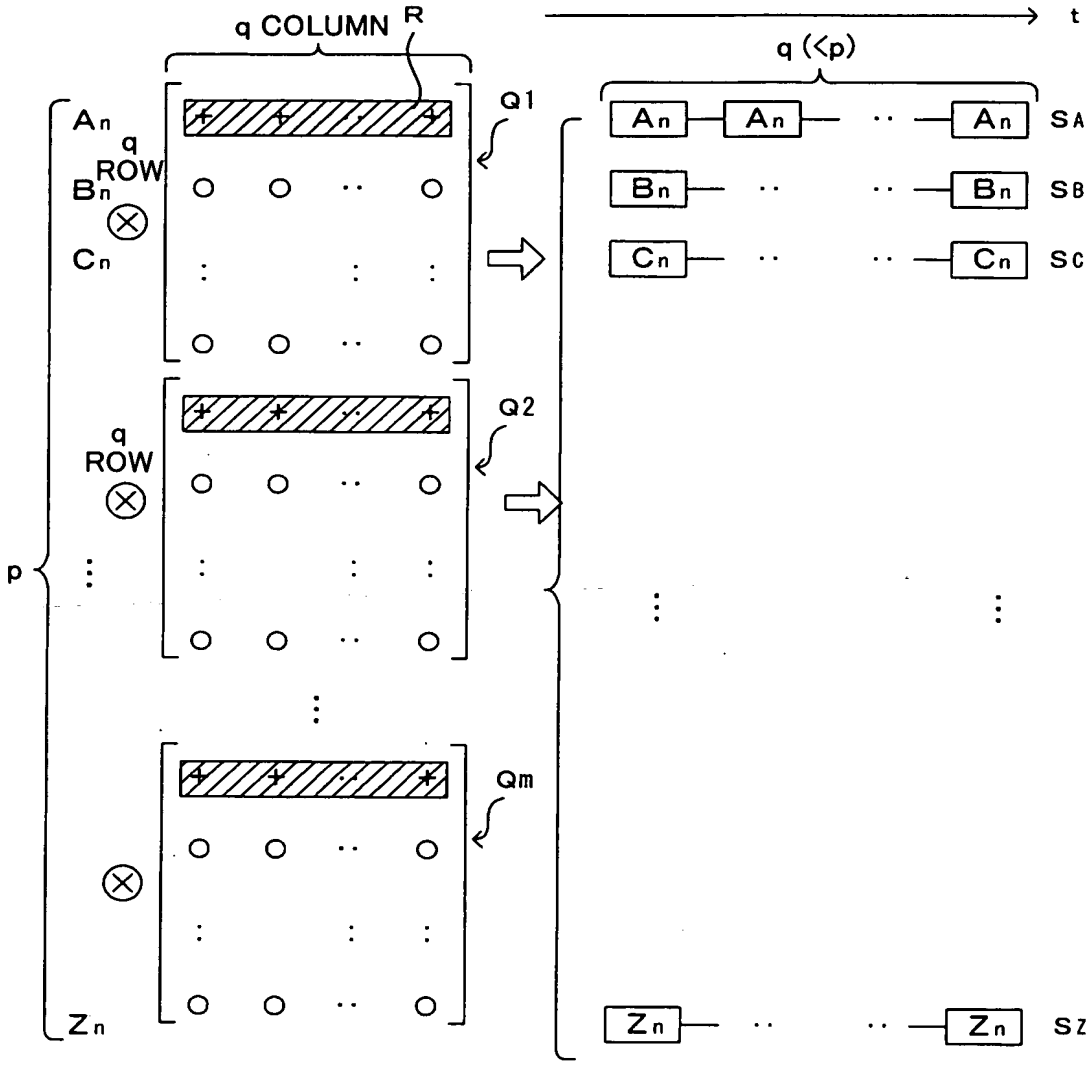


FIG. 2

FIG. 3A

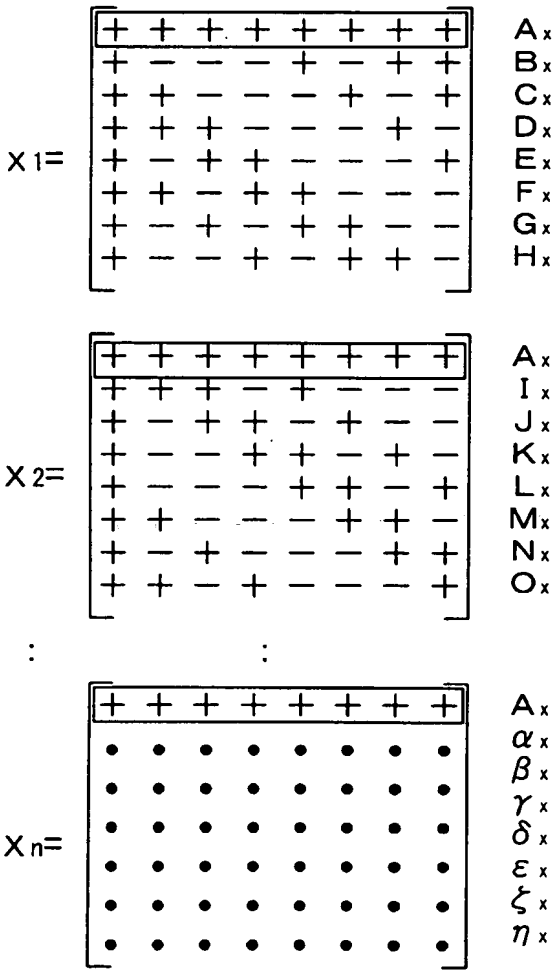
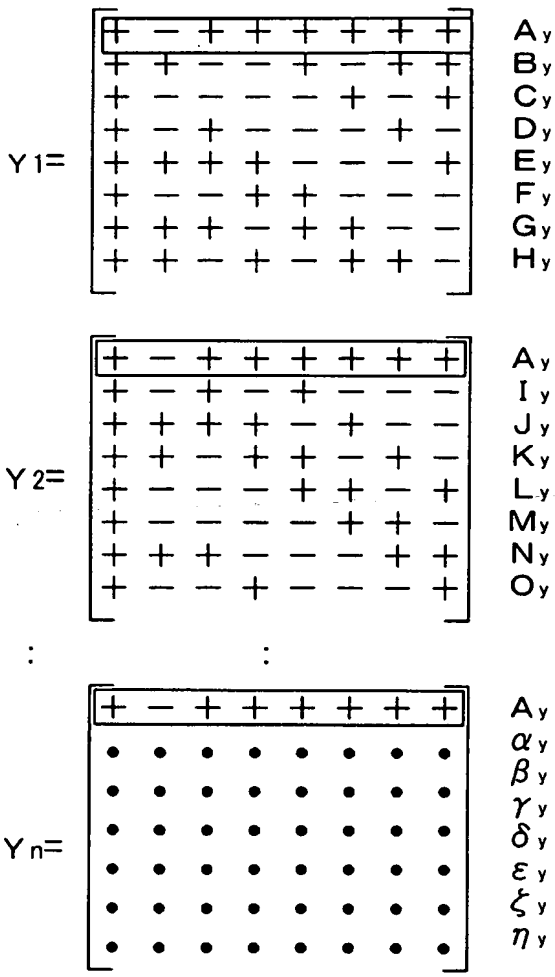

X1=
+ + + + + + + + Ax
+ − − − + − + + Bx
+ + − − − + − + Cx
+ + + − − − + − Dx
+ − + + − − − + Ex
+ + − + + − − − Fx
+ − + − + + − − Gx
+ − − + − + + − Hx
X2=
+ + + + + + + + Ax
+ + + − + − − − Ix
+ − + + − + − − Jx
+ − − + + − + − Kx
+ − − − + + − + Lx
+ + − − − + + − Mx
+ − + − − − + + Nx
+ + − + − − − + Ox
: :
Xn=
+ + + + + + + + Ax
• • • • • • • • αx
• • • • • • • • βx
• • • • • • • • γx
• • • • • • • • δx
• • • • • • • • εx
• • • • • • • • ζx
• • • • • • • • ηx

FIG. 3B


Y1=
+ − + + + + + + Ay
+ + − − + − + + By
+ − − − − + − + Cy
+ − + − − − + − Dy
+ + + + − − − + Ey
+ − − + + − − − Fy
+ + + − + + − − Gy
+ + − + − + + − Hy
Y2=
+ − + + + + + + Ay
+ − + − + − − − Iy
+ + + + − + − − Jy
+ + − + + − + − Ky
+ − − − + + − + Ly
+ − − − − + + − My
+ + + − − − + + Ny
+ − − + − − − + Oy
: :
Yn=
+ − + + + + + + Ay
• • • • • • • • αy
• • • • • • • • βy
• • • • • • • • γy
• • • • • • • • δy
• • • • • • • • εy
• • • • • • • • ζy
• • • • • • • • ηy

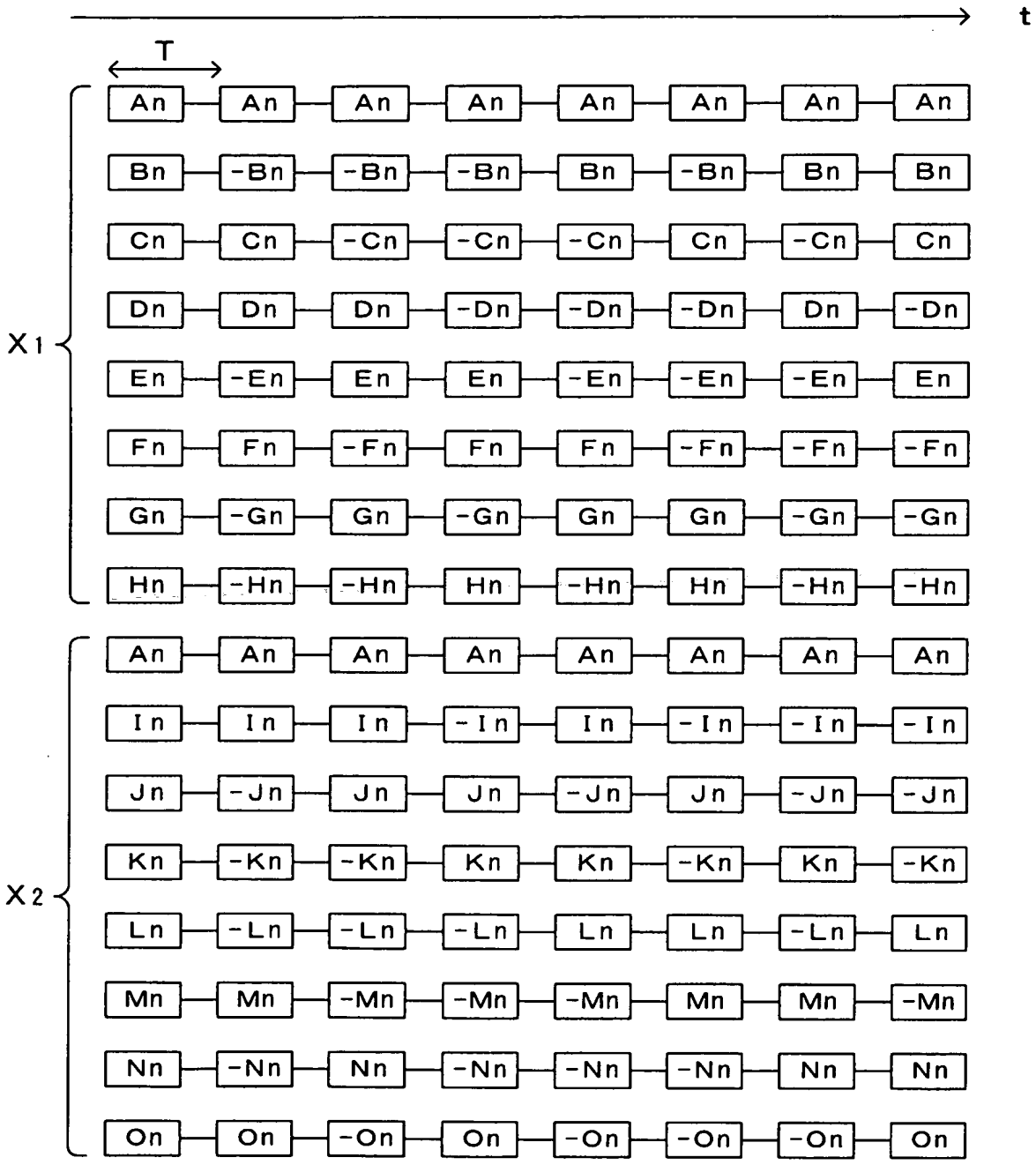

t
T
X1
An An An An An An An An
Bn -Bn -Bn -Bn Bn -Bn Bn Bn
Cn Cn -Cn -Cn -Cn Cn -Cn Cn
Dn Dn Dn -Dn -Dn -Dn Dn -Dn
En -En En En -En -En -En En
Fn Fn -Fn Fn Fn -Fn -Fn -Fn
Gn -Gn Gn -Gn Gn Gn -Gn -Gn
Hn -Hn -Hn Hn -Hn Hn -Hn -Hn
X2
An An An An An An An An
In In In -In In -In -In -In
Jn -Jn Jn Jn -Jn Jn -Jn -Jn
Kn -Kn -Kn Kn Kn -Kn Kn -Kn
Ln -Ln -Ln -Ln Ln Ln -Ln Ln
Mn Mn -Mn -Mn -Mn Mn Mn -Mn
Nn -Nn Nn -Nn -Nn -Nn Nn Nn
On On -On On -On -On -On On

FIG. 4

SIGNAL SEQUENCE FOR MULTIPATH ESTIMATION

$$A_n = a_0\ a_1\ a_2\ \cdots\ a_{N-1}$$

TRANSMISSION DATA

$$B_n = b_0\ b_1\ b_2\ \cdots\ b_{n-1}$$
$$C_n = c_0\ c_1\ c_2\ \cdots\ c_{n-1}$$
$$D_n = d_0\ d_1\ d_2\ \cdots\ d_{n-1}$$
$$E_n = e_0\ e_1\ e_2\ \cdots\ e_{n-1}$$
$$\vdots \qquad \vdots \qquad \vdots \qquad \vdots$$
$$O_n = o_0\ o_1\ o_2\ \cdots\ o_{n-1}$$
$$\uparrow\ \uparrow\ \uparrow \qquad \uparrow$$
$$t_0\ t_1\ t_2 \qquad t_{n-1}$$

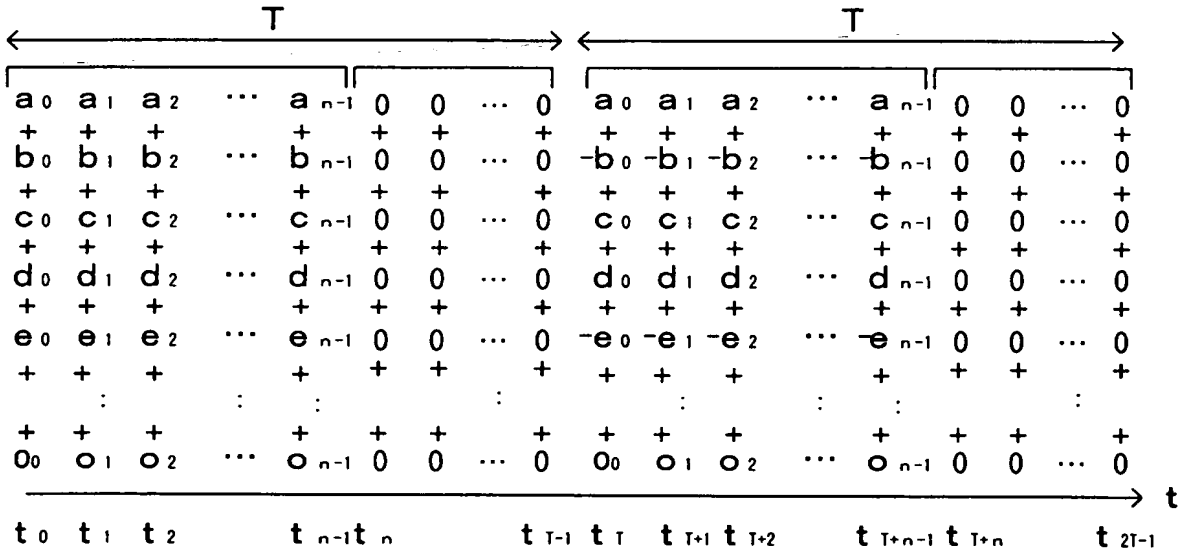


FIG. 5

FIG. 6A

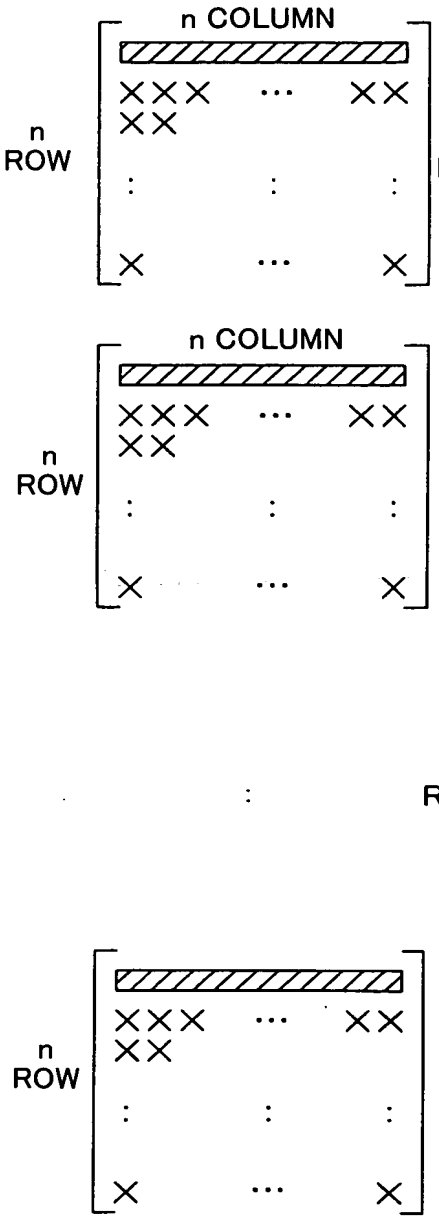


FIG. 6B

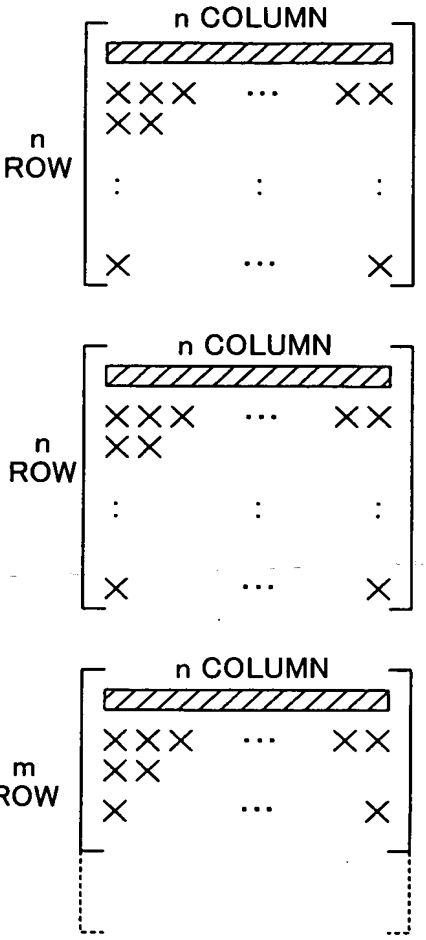


FIG. 6C

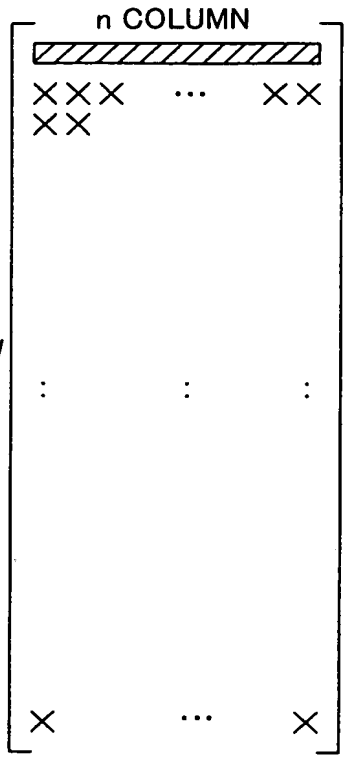


FIG. 7A

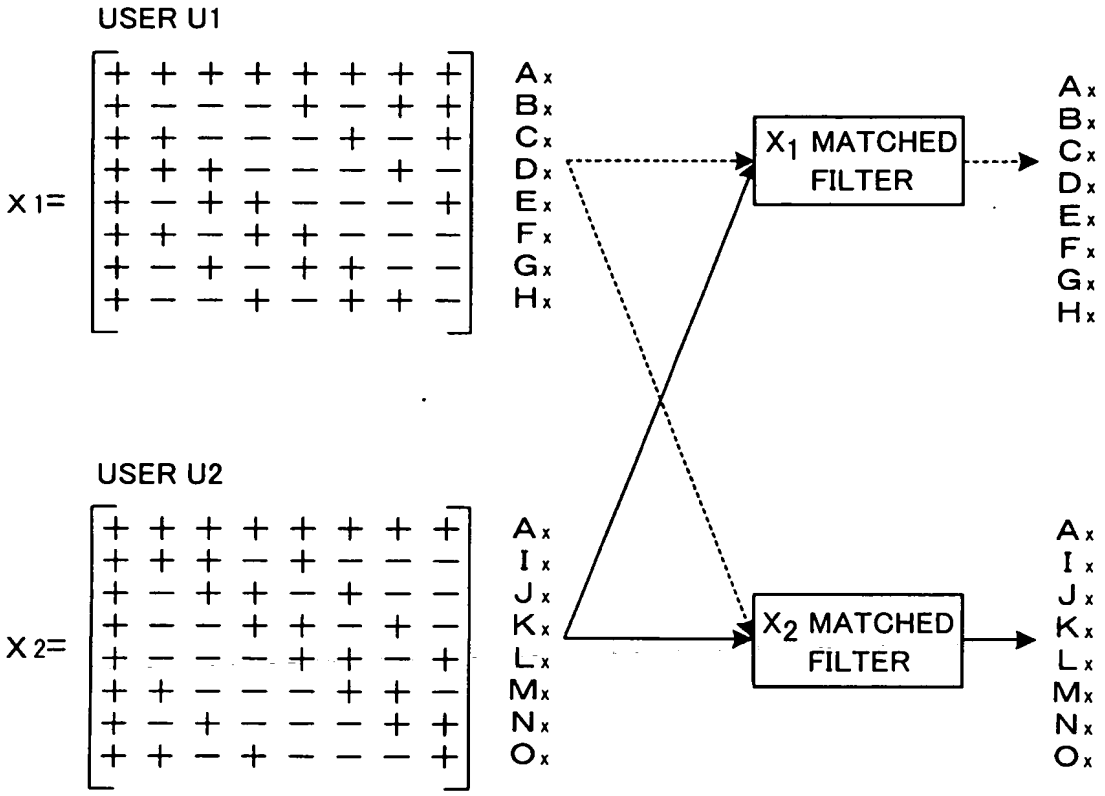

USER U1
X 1=
A x
B x
C x
D x
E x
F x
G x
H x
X1 MATCHED FILTER
USER U2
X 2=
A x
I x
J x
K x
L x
M x
N x
O x
X2 MATCHED FILTER

FIG. 7B

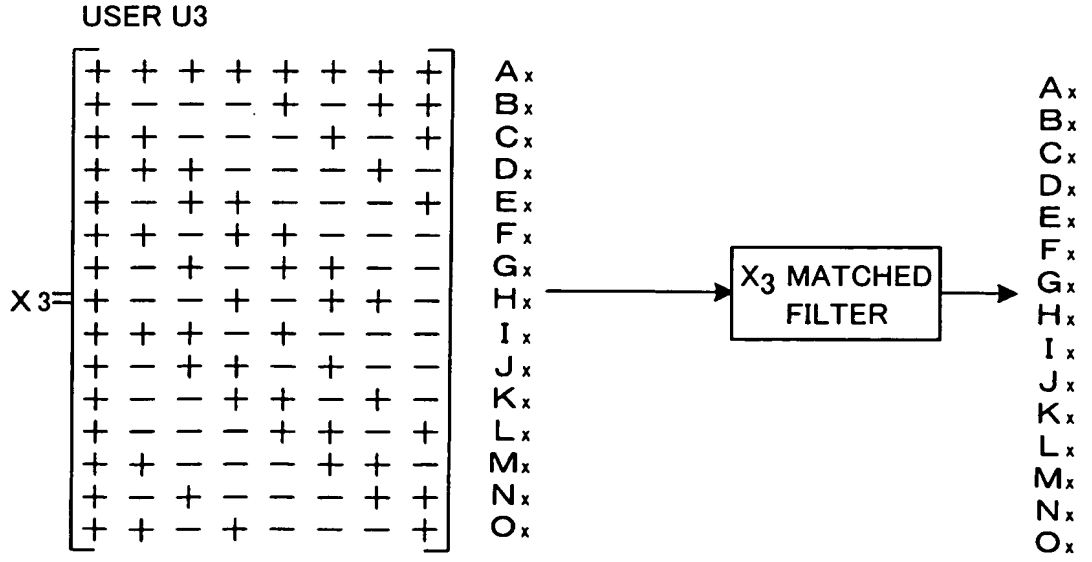

USER U3
X 3=
A x
B x
C x
D x
E x
F x
G x
H x
I x
J x
K x
L x
M x
N x
O x
X3 MATCHED FILTER

FIG. 8A

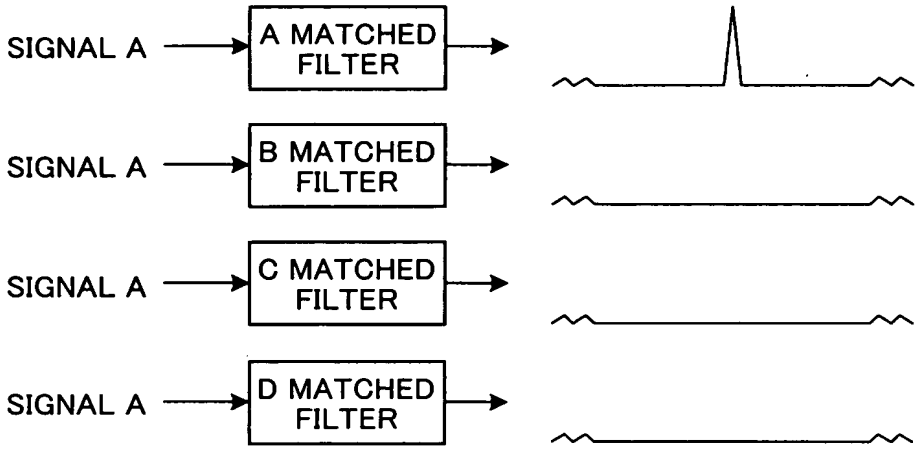
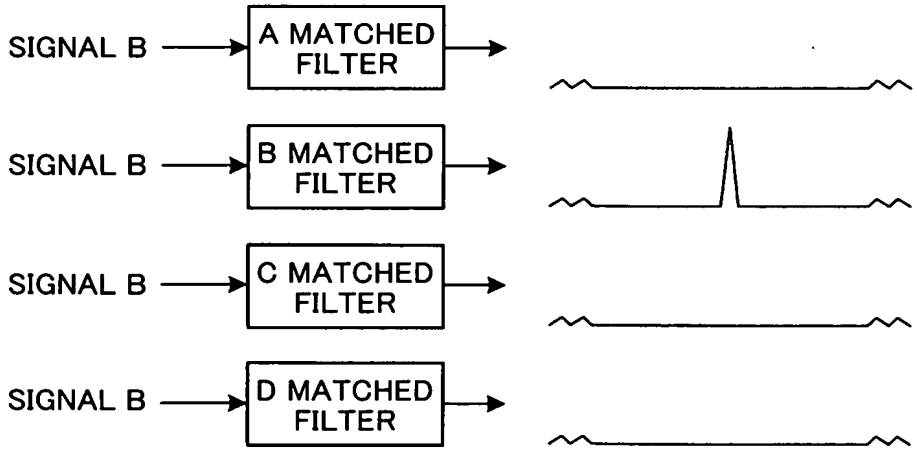

SIGNAL A
A MATCHED FILTER
SIGNAL A
B MATCHED FILTER
SIGNAL A
C MATCHED FILTER
SIGNAL A
D MATCHED FILTER

FIG. 8B


SIGNAL B
A MATCHED FILTER
SIGNAL B
B MATCHED FILTER
SIGNAL B
C MATCHED FILTER
SIGNAL B
D MATCHED FILTER

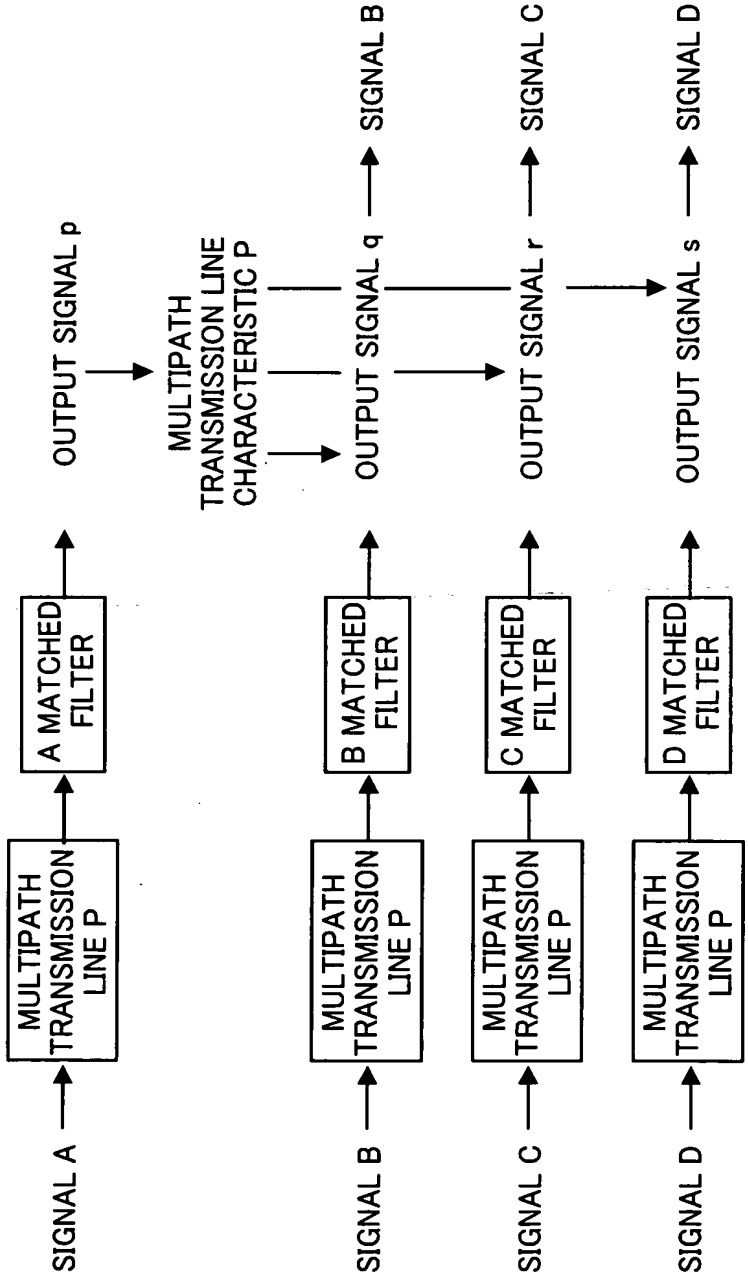

SIGNAL A
SIGNAL B
SIGNAL C
SIGNAL D
MULTIPATH TRANSMISSION LINE P
MULTIPATH TRANSMISSION LINE P
MULTIPATH TRANSMISSION LINE P
MULTIPATH TRANSMISSION LINE P
A MATCHED FILTER
B MATCHED FILTER
C MATCHED FILTER
D MATCHED FILTER
OUTPUT SIGNAL p
OUTPUT SIGNAL q
OUTPUT SIGNAL r
OUTPUT SIGNAL s
MULTIPATH TRANSMISSION LINE CHARACTERISTIC P
SIGNAL B
SIGNAL C
SIGNAL D

FIG. 9

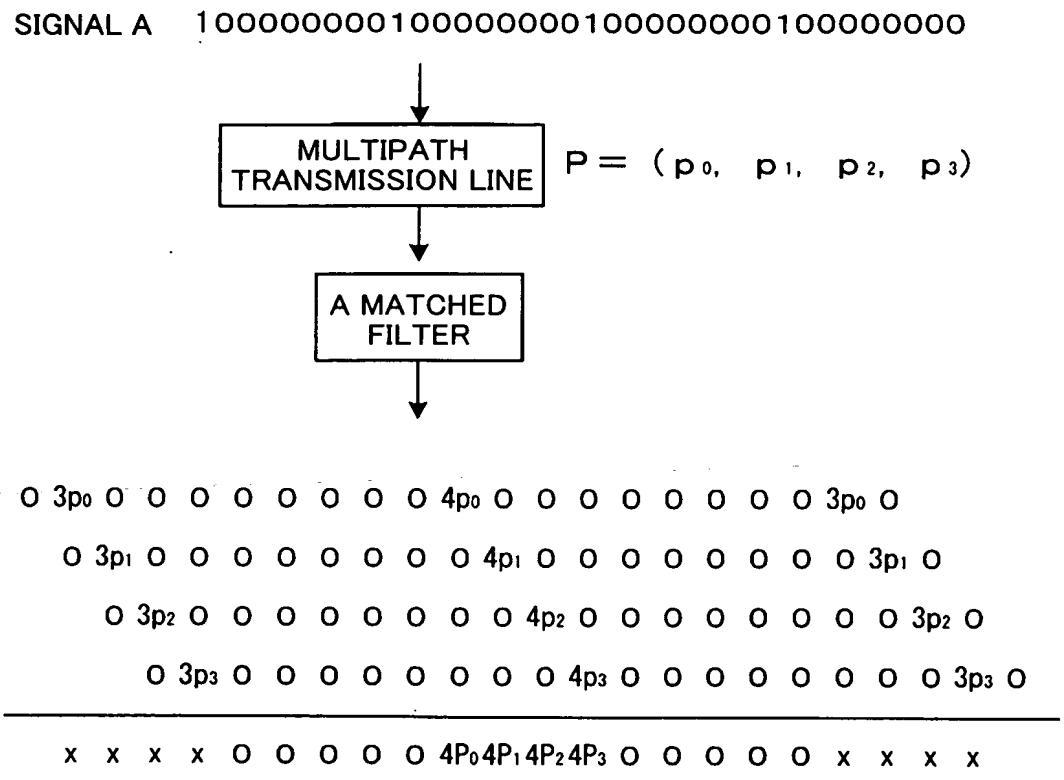

SIGNAL A 100000000100000000100000000100000000
MULTIPATH TRANSMISSION LINE
P = (p0, p1, p2, p3)
A MATCHED FILTER
0 3p0 0 0 0 0 0 0 0 0 4p0 0 0 0 0 0 0 0 0 3p0 0
0 3p1 0 0 0 0 0 0 0 0 4p1 0 0 0 0 0 0 0 0 3p1 0
0 3p2 0 0 0 0 0 0 0 0 4p2 0 0 0 0 0 0 0 0 3p2 0
0 3p3 0 0 0 0 0 0 0 0 4p3 0 0 0 0 0 0 0 0 3p3 0
x x x x 0 0 0 0 0 4P0 4P1 4P2 4P3 0 0 0 0 0 x x x x

FIG. 10

FIG. 11A

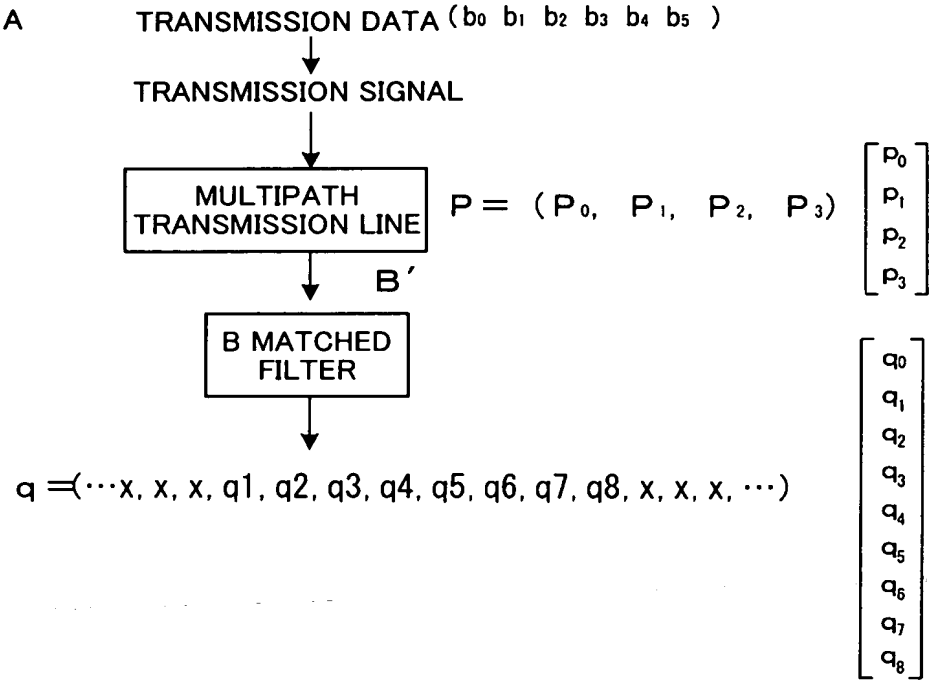


FIG. 11B

$$\begin{bmatrix} b_0 & 0 & 0 & 0 \\ b_1 & b_0 & 0 & 0 \\ b_2 & b_1 & b_0 & 0 \\ b_3 & b_2 & b_1 & b_0 \\ b_4 & b_3 & b_2 & b_1 \\ b_5 & b_4 & b_3 & b_2 \\ 0 & b_5 & b_4 & b_3 \\ 0 & 0 & b_5 & b_4 \\ 0 & 0 & 0 & b_5 \end{bmatrix} \begin{bmatrix} p_0 \\ p_1 \\ p_2 \\ p_3 \end{bmatrix} = \begin{bmatrix} q_0 \\ q_1 \\ q_2 \\ q_3 \\ q_4 \\ q_5 \\ q_6 \\ q_7 \\ q_8 \end{bmatrix}$$

FIG. 12A A MATCHED FILTER

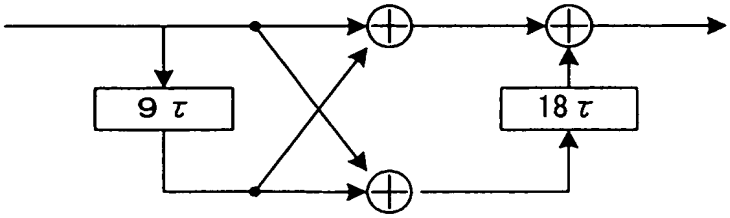


FIG. 12B B MATCHED FILTER

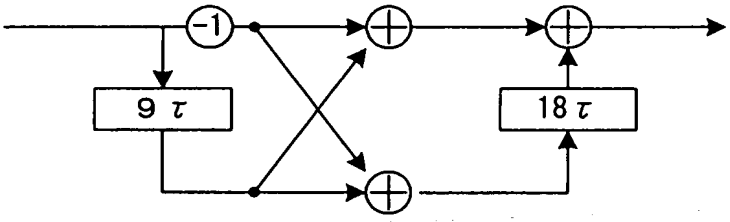


FIG. 12C C MATCHED FILTER

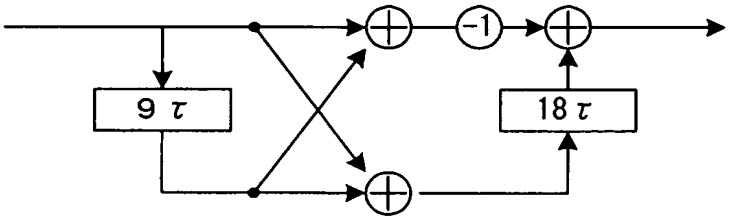


FIG. 12D D MATCHED FILTER

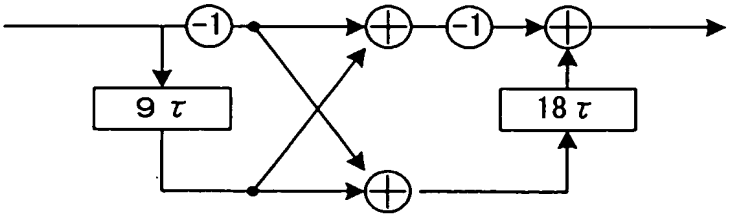


FIG. 13A

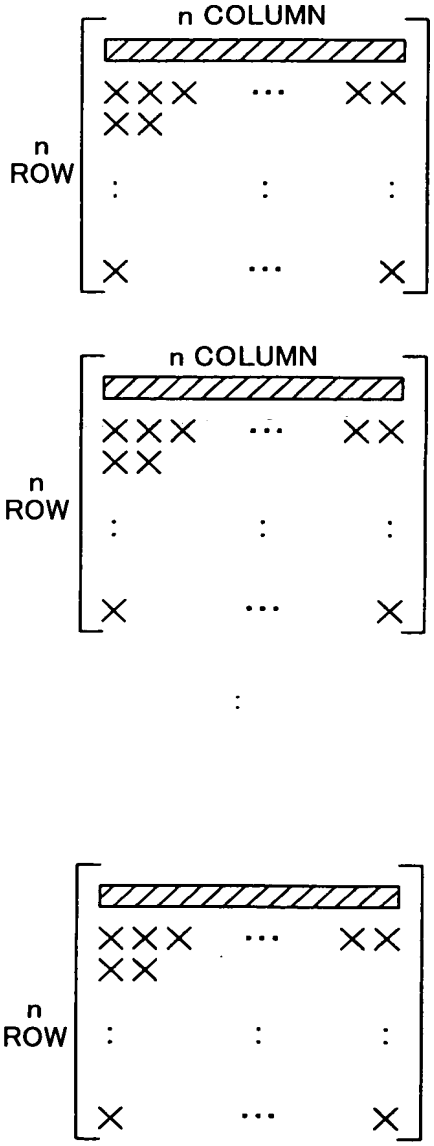
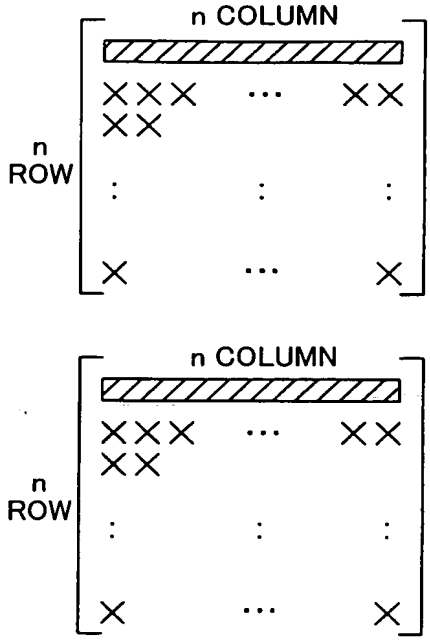


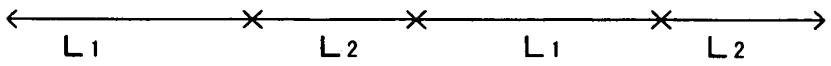
FIG. 13B



SIGNAL SEQUENCE FOR MULTIPATH ESTIMATION

$A_n = a_0\ a_1\ a_2\ \cdots\ a_{n-1}$

$= + + + -\ \cdots\ 0\ 0\ 0\ 0\ +\ -\ +\ +\ \cdots\ 0\ 0\ 0\ 0\ \cdots$



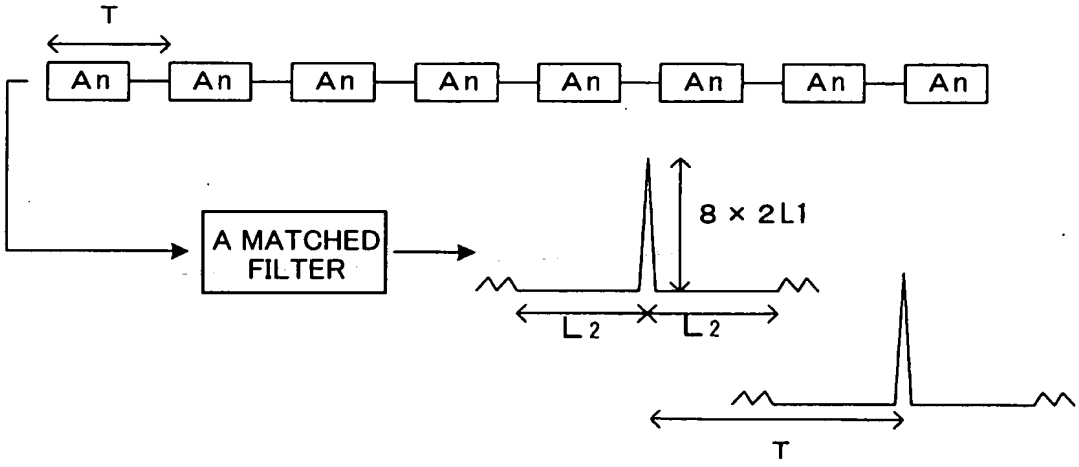


FIG. 14

FIG. 15A

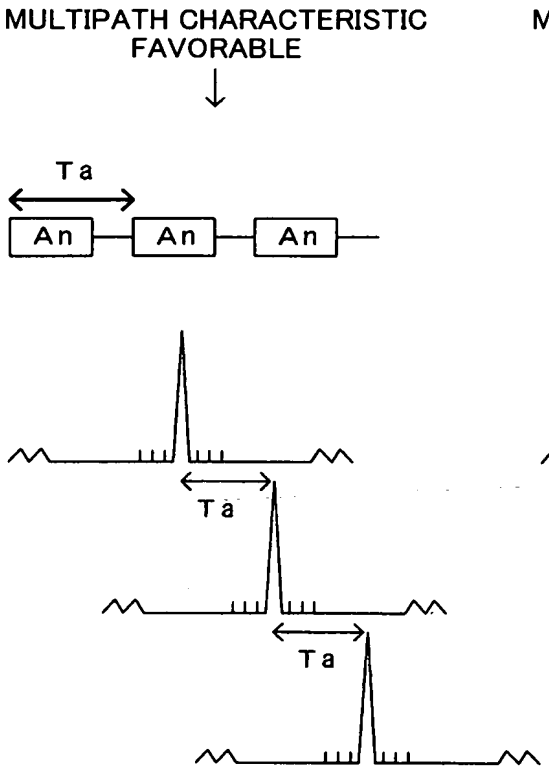
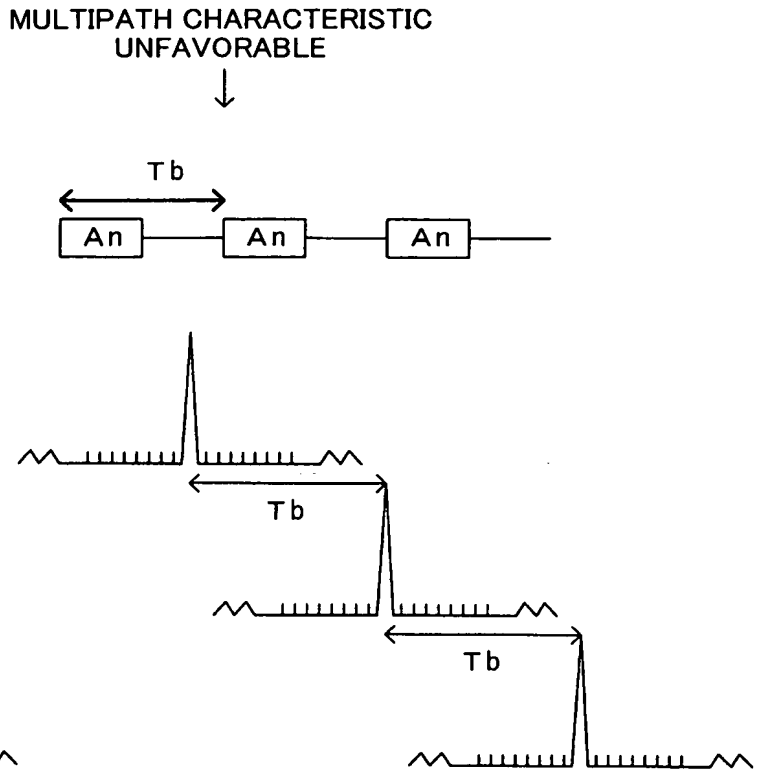


FIG. 15B



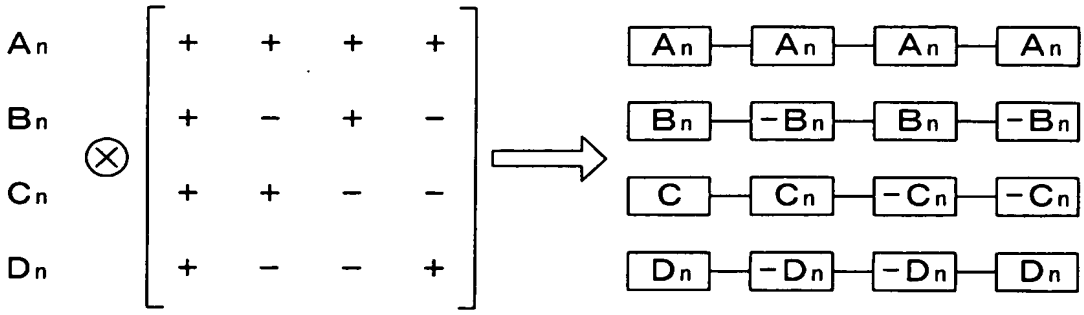


FIG. 16

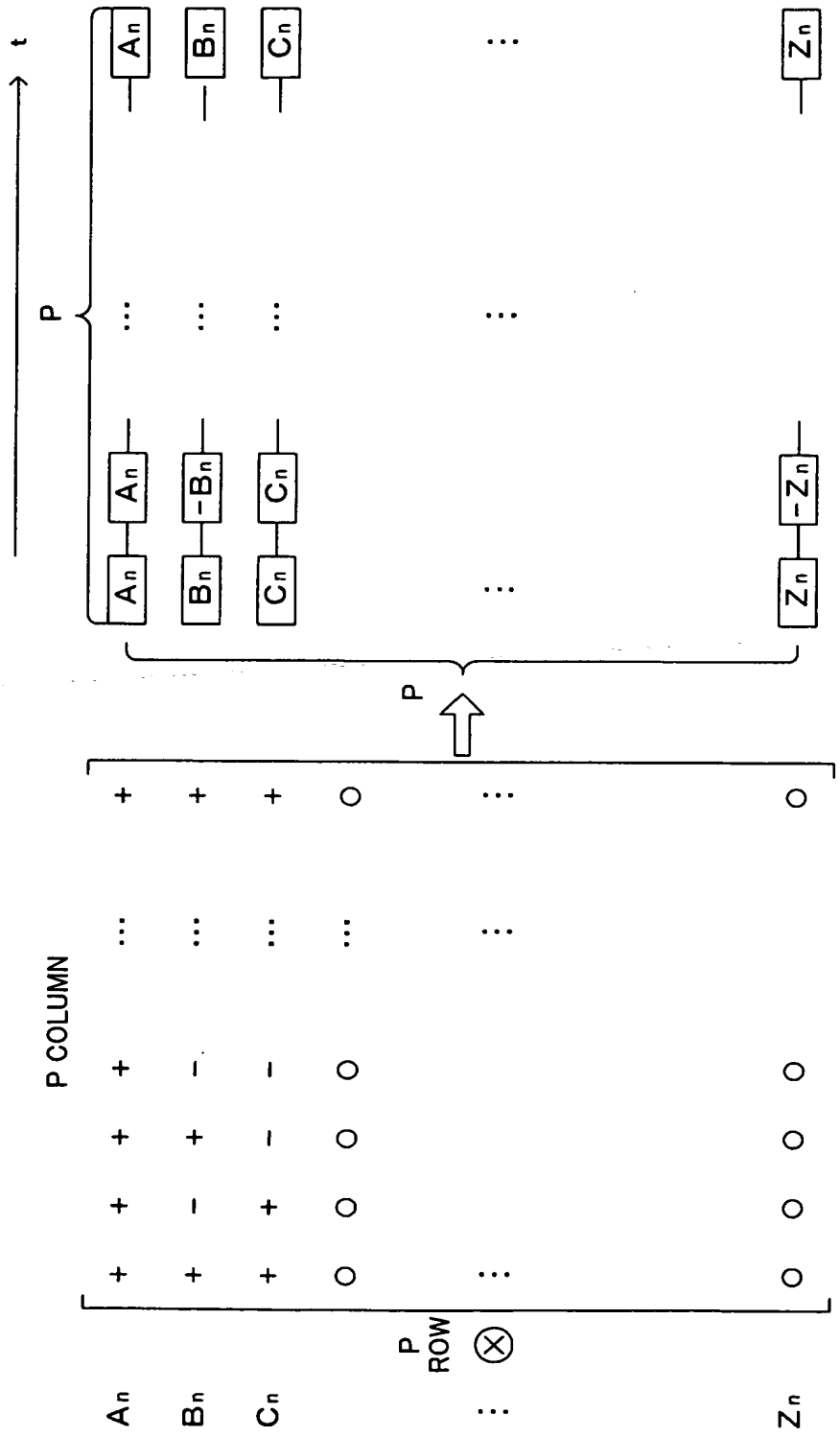


FIG. 17